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Protoblepharon mccoskeri, a new flashlight fish from eastern Taiwan (Teleostei: Anomalopidae)

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Abstract

A new flashlight fish of the genus *Protoblepharon* is described based on a large male specimen collected from eastern Taiwan, northwestern Pacific Ocean. It differs from the only congener, *P. rosenblatti*, in having the following characters: a smaller light organ with a larger cup; a deeper body; a strongly convex dorsal profile; a smaller and anterior placed pelvic fin, the appressed fin reaching to the midpoint between origins of pelvic and anal fins; a smaller pectoral fin, the apressed fin not reaching the lateral line; second dorsal-fin spine the longest; a shorter snout; a smaller eye; about 30 scale rows between first dorsal-fin base and lateral line; and more than 260 scale rows along the body axis.

Key words: Pisces, Beryciformes, taxonomy, new species

Introduction

In a recent visit to the Fugang fishing port of eastern Taiwan, the first author purchased a large, black fish specimen (305 mm SL, Fig. 1A) awaiting sale in the auction. This specimen proved to be a male flashlight fish (Anomalopidae) of *Protoblepharon*, a genus characterized by having 21 gill rakers (as 4 plates and 17 rod-shaped rakers) on the first arch, a relatively small rotatable light organ, no postorbital papillae, and a very small gap between the lacimal and nasal for passage of the stalk. However, it differs in many aspects from the only congener *Protoblepharon rosenblatti*, a species described by Baldwin et al. (1997) based on a single 220 mm SL specimen collected from the Cook Islands in the south central Pacific Ocean at a depth of 274 m. *Protoblepharon rosenblatti* was mentioned by the latter authors subsequently (Paxton & Johnson, 1999; Randall, 2005), but no additional information was added to that in the original description. The newly collected specimen represents the second specimen and the first record for of the genus in North Pacific Ocean.

The flashlight fish family Anomalopidae currently comprises six genera, three monotypic and three genera with two species each. The purpose of the study is to describe and name a new species of *Protoblepharon* and compare it to its only known congener, *P. rosenblatti*.

Material and methods

The specimen was fixed in 5% formalin, subsequently transferred to 50% isopropanol and deposited in the fish collection of the National Museum of Marine Biology & Aquarium, Taiwan (NMMB-P). A series of detailed photos, a tissue sample (preserved in 95% ethanol) and the sagittal otoliths were taken prior to fixation. Standard length (SL), measured from upper jaw symphysis to posterior end of hypural plate, and head length (HL), measured from upper jaw symphysis to posterior margin of opercle, were used throughout. Predorsal, prepelvic and preanal lengths, measured from upper jaw symphysis to fin origins; body depth, measured at origin of dorsal fin and body width measured at base of pectoral fin; caudal peduncle length, measured in two portions, one from posterior end

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of dorsal-fin base and one from posterior end of anal fin base, both to posterior end of hypural plate; caudal peduncle depth measured from least depth; snout length, measured from symphysis of upper jaw to anterior margin of orbit; eye diameter, measured from widest horizontal distance of eye and orbital diameter, length of longest horizontal distance of bony margin; interorbital width, measured from least distance of upper bony margins of orbit; light organ, measured from widest horizontal distance; lengths of fin spines, measured from base to tip of each spine (third dorsal spine length includes a broken piece connected by fin membrane); pectoral-fin length, pelvic-fin length, dorsal-fin height and anal-fin height were measured from those of longest fin rays; caudal-fin length, measured from the longest fin ray on upper lobe. Numbers of vertebrae, pterygiophores and configuration of caudal skeleton were determined from radiographs. Right suspensorium, jaws and opercular series of the holotype were dissected for study and to expose the gill arches and facilitate counting the gill rakers. Morphometric data were taken by digital calipers to nearest 0.1 mm, except for SL which was to nearest 1 mm. Methods for taking meristic data followed Baldwin et al. (1997). Supraneural and dorsal pterygiophore interdigitation formula follow that of Johnson (1981). Data from the holotype of *P. rosenblatti* were recounted/remeasured to compare with those of the new species. Terminology of structures associated with light organ followed Johnson and Rosenblatt (1988) and those of otolith followed Furlani et al. (2007). Institutional abbreviations follow Fricke and Eschmeyer (2010).

Protoblepharon Baldwin, Johnson & Paxton, 1997

Protoblepharon mccoskeri sp. nov.

New English name: Taiwanese flashlight fish
Figures 1A–C, 2, 3, 4, 5A, 6A–B, 7, 8, Table 1–3

Holotype. NMMB-P10807, 305 mm SL, Fugang Fishing port, Taitung, E. Taiwan, ca. 22°47.5'N, 121°11.6'E, ca. 300 m depth, 25 Dec. 2010, hook and line, purchased by H.-C. Ho.

Diagnosis and comparison. A species of *Protoblepharon* differing from its only congener, *P. rosenblatti*, in having the following: body deeper (2.3 in SL vs. 2.8 in SL in *P. rosenblatti*); dorsal profile more strongly convex ; pelvic fin origin anterior to (vs. posterior to) vertical through origin of dorsal fin, prepelvic length and pectoral fin much shorter, the appressed fin falling short of (vs. reaching) lateral line; pelvic fin shorter, the appressed fin falling short of (vs. reaching well beyond) midpoint between pelvic and anal fin origins; eye and light organ smaller; longest dorsal-fin spine the second (vs. the seventh); first, second and sixth dorsal-fin spines longer; seventh dorsal-fin spine much shorter; pseudobranch filaments 38 (vs. ca. 27); scale rows along vertical between origin of dorsal fin and lateral line ca. 30 (vs. ca. 18); scale rows along body axis over 260 (vs. ca. 145); enlarged scales surrounding anal fin base 37 (vs. 21 at anal fin base); single row of enlarged cycloid, plate-like scales along the margin of gill cavity (vs. 2–3 irregular rows of small scales).

Description. Counts and measurements of the holotype compared to those of *P. rosenblatti* are provided in Tables 1–3.

Head length 2.7 in SL, 1.1 in body depth; body depth 2.3 in SL; body width 4.8 in SL, 1.8 in HL; snout length 4.0 in HL; eye diameter 5.9 in HL; orbital diameter 4.4 in HL, 1.2 in interorbital width; interorbital width 3.7 in HL; light organ length 7.5 in HL; pre-dorsal length 2.3 in SL; pre-pelvic length 2.3 in SL; pre-anal length 1.3 in SL; pectoral fin length 2.0 in HL; dorsal fin height 2.4 in HL; 1st dorsal-fin spine length 5.1 in HL; 2nd dorsal-fin spine length 4.5 in HL; 3rd dorsal-fin spine length 5.4 in HL; 4th dorsal-fin spine length 5.4 in HL; 5th dorsal-fin spine length 7.5 in HL; 6th dorsal-fin spine length 8.2 in HL; 7th dorsal-fin spine 6.7 in HL; pelvic fin length 2.4 in HL; pelvic-fin spine length 3.9 in HL; anal fin height 3.4 in HL; 1st anal-fin spine length 11.8 in HL; 2nd anal-fin spine 6.5 in HL; caudal peduncle depth 3.8 in HL; caudal peduncle length 2.1 in HL; caudal fin length 1.8 in HL.

Body compressed but relatively thick (width 2.0 in depth) and deep (depth at origin of dorsal fin 1.1 times head length, 1.5 in length without head). With mouth open, profile sloping strongly from occiput to snout and convex in region of mesethmoid, then dropping slightly to symphysis of upper jaw (Fig. 1A); upper-jaw symphysis below level of horizontal through middle of eye (Fig. 1B). Nostrils anterior, completely dorsal to eye with mouth open, the anterior with thickend posterior rim. Jaws originating anteriorly below horizontal through middle of eye, maxilla extending posteriorly to vertical through anterior of eye. Posterior supramaxilla ovoid, anterodorsal surface with small pointed process extending anteriorly along posterodorsal egde of small anterior supramaxilla. Posterior supramaxilla covering most of posterior portion of maxilla, posteroventral corner of maxilla exposed and covered with tiny black papillae. Distinct notch at symphysis of premaxillae, presumably accommodating small dentigerous knob at symphysis of dentaries when mouth closed.

TABLE 1. Meristic data of holotypes of *Protoblepharon mccoskeri* **sp. nov.** and *P. rosenblatti*. The data for holotype *P. rosenblatti* were recounted in present study.

	P. mccoskeri **sp. nov.** NMMB-P10807	*P. rosenblatti* AMS I.24275-001
Dorsal fin spines and rays	VI–I,14	VI–I,14
Anal fin spine and rays	II, 11	II, 11
Pectoral fin rays	ii+15+i	ii+15+i
Pelvic fin rays	I, 5	I, 5
Caudal fin rays	11, 10+9, 9	10, 10+9, 9
Gill rakers on 1st gill arch	2+4+13+2=21	2+5+12+2=21
Vertebrae	14+16=30	14+16=30
Scale rows between dorsal-fin base and Lateral line scales	ca. 30	ca. 18
Lateral scale rows	59 & 61	59 & 60
Body scale rows	>260	ca. 145
Abdominal scutes	13	13
Enlarged scales on dorsal-fin base	100	97
Enlarged scales on anal-fin base	37	22

Premaxillae, including most of lateral and medial surface, covered with bands of villiform teeth; no teeth at symphyseal notch (Fig. 1C). Each dentary with narrow band of villiform teeth posteriorly, patch of slightly larger teeth covering entire symphysis, except for small median notch (Fig. 1C). Vomer edentulous, palatines with well-developed, J-shaped patch of villiform teeth (anterior end of patch "hooked.") Bones of head and pectoral girdle covered with numerous, rugose to minutely serrate ridges. Cleithrum with large exposed surface posteriorly, margin smooth. Supracleithrum almost covered by opercle (Fig. 1B, 2). Anterior infraorbitals enlarged, covering anteroventral corner of orbit, and slightly flared laterally, forming medially sloping plate. Laterosensory canals of head appearing as channels of dark skin surrounded by bone, skin covered with small black papillae and perforated frequently by pores.

Eye relatively small, diameter 5.9 in HL. Notch at posterodorsal corner of orbit (Fig. 1B). No fleshy papillae on posterior rim of orbit. Light organ (Fig. 3) relatively narrow and small, length 7.5 in HL. Light organ free posteriorly, with a relatively wide cup supporting its anterior end and extending posteriorly along entire ventral surface of light organ as a thin ovoid plate. Strongly elevated ridge on anterior portion of cup creating deep groove between itself and anterior portion of light organ. Anterior portion of fibrocartilaginous stalk continuous with its contralateral member across snout, with no attenuation at commissure. Posterior portion of stalk twisted, passing through small gap between lacrimal and nasal. Many tiny black papillae on outer surface of stalk followed by some large black column-like papillae at anterodorsal corner of light organ complex. Organ capable of being rotated downward into pocket below eye and medial to infraorbitals. When occluded, dorsal margin of light organ well below infraorbital rim. Black elastic shutter membrane attached along outer margin of suborbital pocket, erectible with rotation of light organ (Figs. 4A–C).

Scales mostly spinoid type of Roberts (1993), except for series of enlarged smooth scales on gill chamber near isthmus; enlarged sculptured scales along lateral line (Fig. 2); midventral area posterior to pelvic-fin base with series of 13 enlarged, keeled scutes followed by 9 enlarged scales surrounding anus (Fig. 5), and many enlarged scales along bases of dorsal and anal fins (Fig. 6A). Lateral line covered by 59 (right side) and 61 (left side) enlarged spinoid scales; 100 (48 right, 52 left) enlarged scales along dorsal-fin base and 37 (18 right, 19 left) enlarged scales along anal-fin base, all variable in size. Row of enlarged irregular shaped cycloid scales along outer margin of gill chamber (Fig. 6B). Large area of slightly enlarged spinoid scales posterior to gill chamber between lateral line and pectoral fin base, followed by numerous small spinoid scales (Fig. 2). About 30 irregular rows of spinoid scales between dorsal-fin base and lateral line; about 40 irregular rows of spinoid scales between lateral line and origin of anal fin; more than 260 rows of scales along body axis (all difficult to count because of irregular distribution of scales). Head mostly scaleless, a few thick, heavily sculptured scales at anterodorsal corner of opercle, scales coalescing on cheek to form strong bony covering (Figs. 1B–C). Gular region naked, with low, pigmented, transverse ridges.

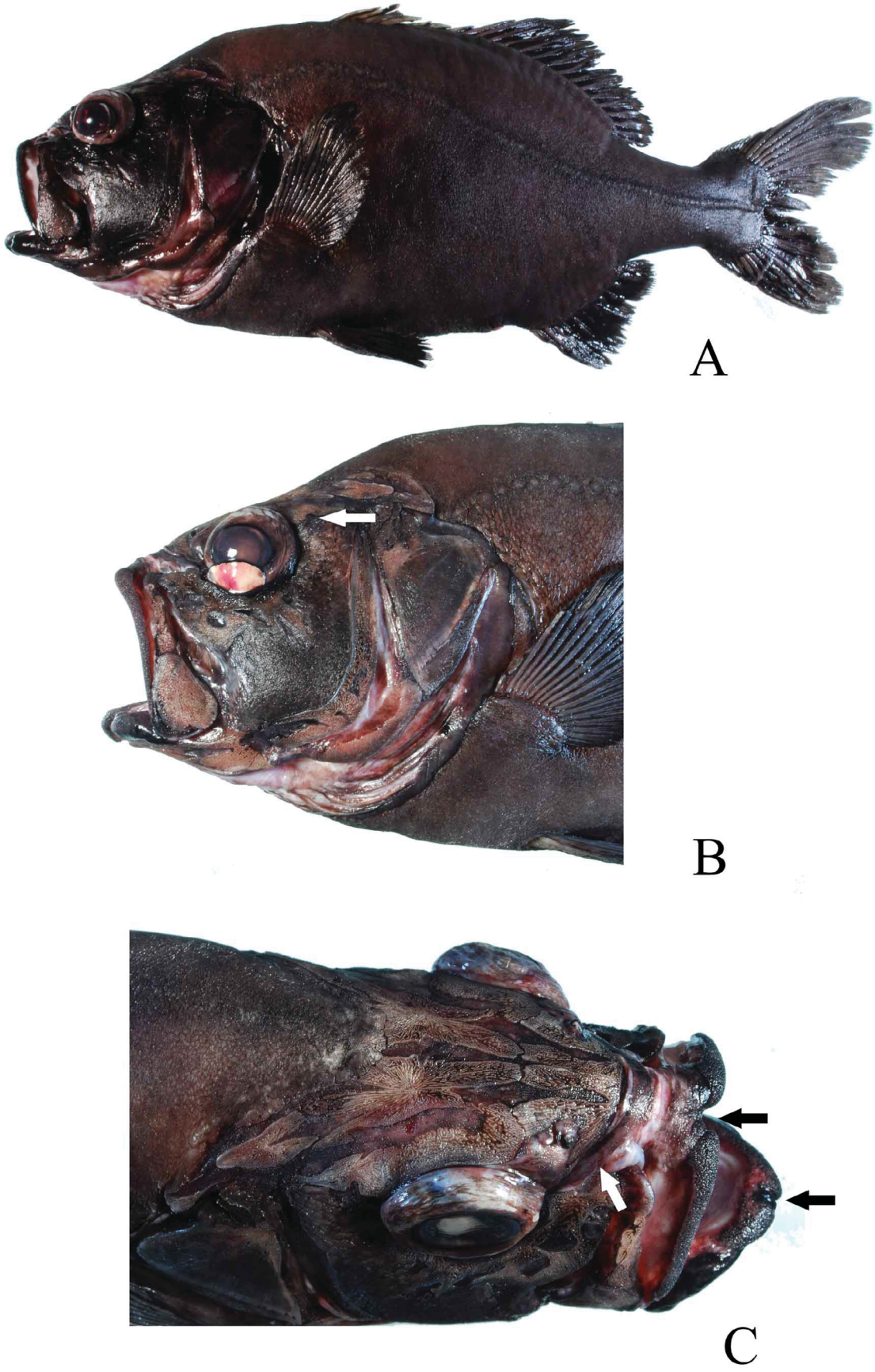

FIGURE 1. *Protoblepharon mccoskeri*, holotype, NMMBP 10807, 305 mm SL, fresh specimen. A. Left lateral view of body. B. Left lateral view of head, arrow indicates channel at posterolateral corner of orbit. C. Right dorsolateral view of head, white arrow indicates gap between lacrimal and nasal; black arrows indicate symphyseal notch in upper and lower jaws.

TABLE 2. Morphometric data of holotypes of *Protoblepharon mccoskeri* **sp. nov.** and *P. rosenblatti*. The data for holotype *P. rosenblatti* were remeasured in present study.

	P. mccoskeri **sp. nov.** NMMB-P10807		*P. rosenblatti* AMS I.24275-001	
Standard length	305 mm		220 mm	
	% SL	% HL	% SL	% HL
Head length	37.3	100.0	38.1	100.0
Predorsal length	44.3	118.9	44.3	116.3
Prepelvic length	44.1	118.4	50.8	133.3
Preanal length	76.6	205.5	72.1	189.3
Body depth	42.8	114.9	37.9	99.5
Body width	21.0	56.2	19.9	52.1
Caudal peduncle depth	11.2	30.0	11.2	29.3
Caudal peduncle length (Post-dorsal fin)	22.5	60.4	19.0	49.7
Caudal peduncle length (Post-anal fin)	19.7	52.9	21.4	56.2
Snout length	9.2	24.8	11.1	29.2
Eye diameter	6.3	16.9	6.3	16.6
Orbital diameter	9.7	26.0	9.8	25.7
Interorbital width	11.6	31.1	10.5	27.4
Light-organ length	5.0	13.4	5.5	14.6
Pectoral-fin length	18.5	49.7	22.4	58.8
Pelvic-fin length	15.3	41.0	17.5	45.8
Pelvic-spine length	9.6	25.8	11.6	30.4
Dorsal-fin height	15.5	41.6	damaged	damaged
1st dorsal-spine length	7.2	19.4	5.8	15.3
2nd dorsal-spine length	8.3	22.2	7.0	18.4
3rd dorsal-spine length	7.0	18.6	8.1	21.4
4th dorsal-spine length	6.9	18.4	8.3	21.8
5th dorsal-spine length	5.0	13.4	4.7	12.3
6th dorsal-spine length	4.5	12.1	3.7	9.7
7th dorsal-spine length	5.5	14.9	8.4	22.1
1st anal-spine length	3.1	8.4	2.6	6.8
2nd anal-spine length	5.7	15.3	5.6	14.7
Anal-fin height	10.9	29.3	damaged	damaged
Caudal-fin length	20.5	54.9	damaged	damaged
Shortest caudal fin length	7.3	19.5	8.2	21.6

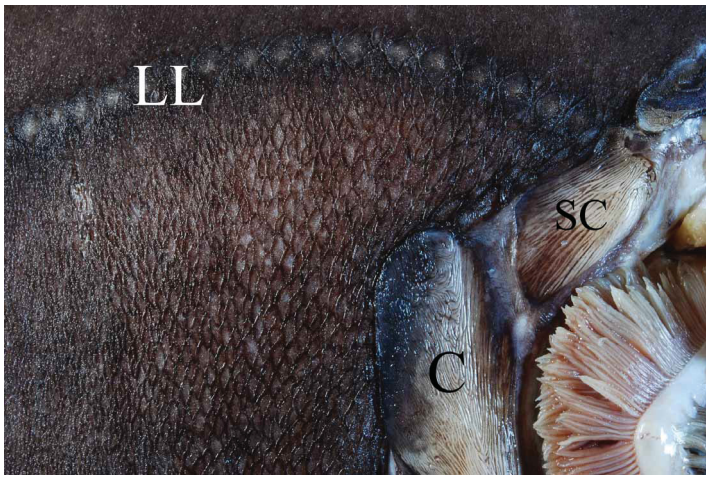

FIGURE 2. *Protoblepharon mccoskeri*, preserved holotype, right side, operculum removed, pectoral fin deflected ventrally. Posterodorsal corner of gill chamber showing exposed areas of cleithrum (C), supracleithrum (SC) and squamation between lateral line (LL) and pectoral-fin base. Anterior to right.

Spinous and soft dorsal fins continuous, deeply notched. First dorsal fin with six spines, second spine longest, gradually shorter to sixth. Length of first spine 1.1 in that of second, third 1.2 (measured with a broken piece connected by membrane), fourth 1.2, fifth 1.7, sixth 1.8; length of second spine 1.9 in that of longest third dorsal-fin soft ray. Second dorsal fin with one spine (i.e., seventh dorsal spine) and 15 soft rays, length of spine 1.5 in second spine, third soft ray longest, gradually shorter to last ray. First dorsal-fin soft ray unbranched, its length about two-thirds of longest ray; remaining soft rays all branched, the last split to base. Anal fin shallower than dorsal fin, with 2 spines and 11 branched soft rays, length of second (longest) soft ray about 1.4 in that of dorsal

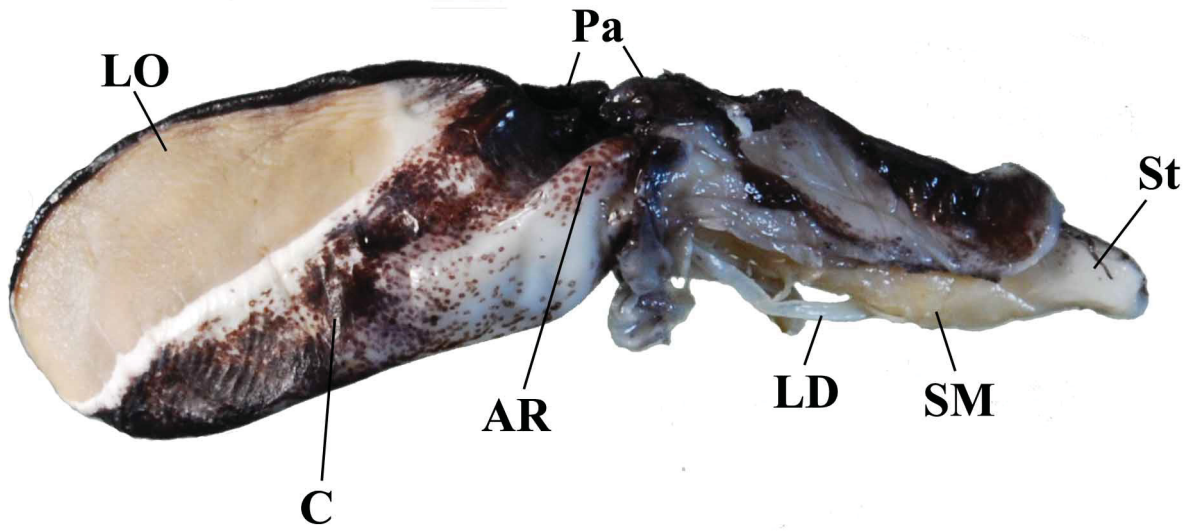

FIGURE 3. *Protoblepharon mccoskeri*, preserved holotype. Light organ complex removed from right side in ventrolateral view. AR, anterior ridge; C, cup; LD, Ligament of Diogenes; LO, light organ; Pa, papillae; SM, stalk muscle; St, stalk (covered by skin). Anterior to right.

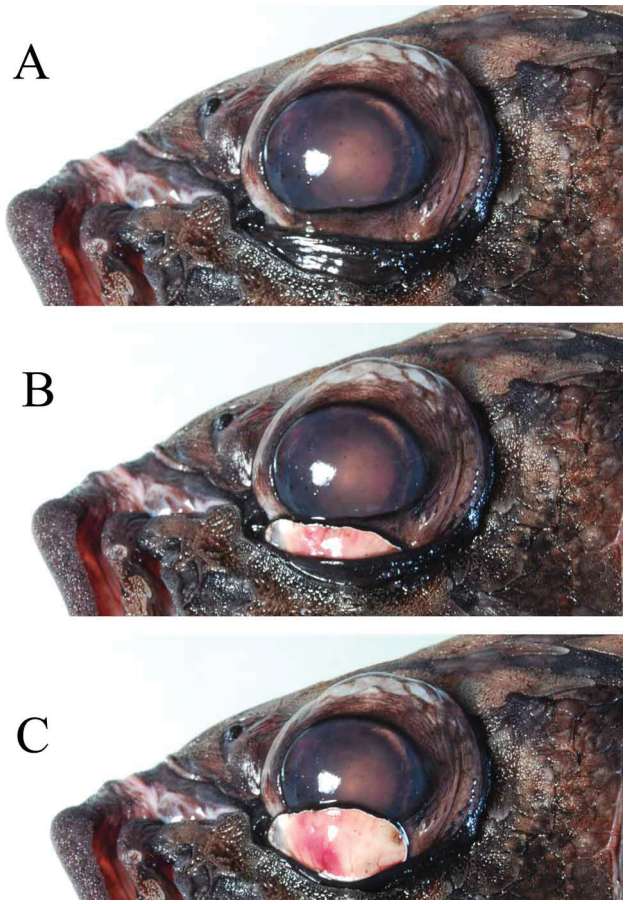

FIGURE 4. *Protoblepharon mccoskeri*, fresh holotype, left side. A. Light organ fully occluded. B. Light organ half occluded. C. Light organ fully exposed.

fin, last ray spilt to base. Caudal fin deeply forked, with 11 procurrent and 10 principal rays (uppermost unbranched) in upper lobe and 9 procurrent and 9 principal rays (lowermost one unbranched) in lower lobe. Pectoral-fin base nearly horizontal, with 18 rays (2 simple rays +15 branched rays + 1 simple ray), sixth ray longest, appressed fin not reaching lateral line. Pelvic fin inserting anterior to vertical from dorsal-fin origin, relatively small, with one short spine and 5 branched soft rays, first soft ray longest, appressed fin not reaching mid-point between pelvic and anal fin origins.

Gill rakers rod-shaped with plate-like base or flat tooth plates, all bearing numerous tiny teeth; three rows on first to third arches and two rows on fourth: counts in Table 3. A very large tooth patch on each side of third pharyngobranchial, absent from the rest pharyngobranchials. A very large tooth patch on each side of fifth ceratobranchial. Basibranchials edentulous.

Axial and caudal skeleton: Fourteen abdominal vertebrae and 16 caudal vertebrae, including second ural centrum. Dorsal fin supported by 21 anteroposteriorly expanded pterygiophores (seven spinous, 14 soft ray); one supraneural anterior to the first and second neural spines. Supraneural and pterygiophore insertion formula 0/0/1+1/1/1/1/1/1/1/1/1/2/1/2/3/2. Anal fin supported by 12 anteroposteriorly expanded pterygiophores, first three inserting anterior to haemal spine of first caudal (15th) vertebra.

Neural spine of fourth preural vertebra extends dorsally to base of first procurrent ray. Neural spine of third preural vertebra extends dorsally to support fifth procurrent ray and haemal spine extends posteriorly to support third to ninth procurrent rays. Neural spine of second preural vertebra low, haemal spine of normal length. Three epurals; one parhypural. six hypurals. (Fig. 7).

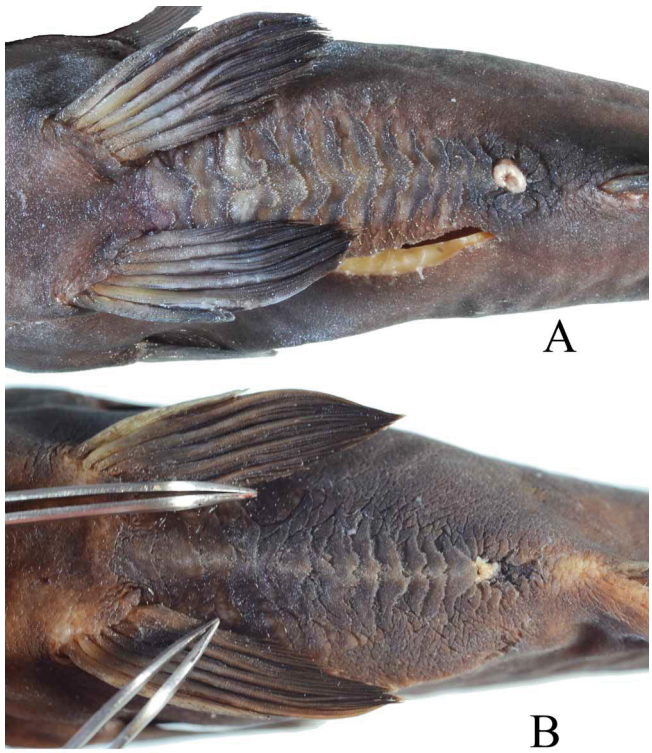

FIGURE 5. Ventral view of abdomen showing enlarged scutes on abdomen, and around anus and posterior extent of tips of appressed pelvic fins A. *Protoblepharon mccoskeri*, preserved holotype. B. *P. rosenblatti*, preserved holotype. Not to scale. Anterior to left.

TABLE 3. Counts of the gill rakers of two species of *Protoblepharon*. The numbers are toothed plates+rakers. Question marks for *P. rosenblatti* are rakers obscured by reverted stomach.

	Upper limb			Lower limb		
	Outer row	Median row	Inner row	Outer row	Median row	Inner row
P. mccoskeri **sp. nov.**						
1st Gill arch	2+4	4+0	1+1	2+13	10+0	2+12
2nd Gill arch	5+2	3+0	3+1	5+11	13+0	0+11
3rd Gill arch	4+0	absent	2+0	3+10	11+0	3+7
4th Gill arch	absent	absent	absent	5+0	absent	2+0
P. rosenblatti						
1st Gill arch	2+5	absent	2+1	2+12	absent	0+14
2nd Gill arch	?+3	absent	0+2	3+12	11+0	1+11
3rd Gill arch	5+1	absent	2+1	3+11	?+0	3+9
4th Gill arch	?	?	?	?	?	?

Otolith morphology: Sagitta otolith fusiform, large in size, 14.9 and 15.4 mm in width respectively (Fig. 8A–B). Distal surface concave, with three ridges on dorsal portion and one ridge on rostrum. Proximal surface slightly convex; dorsal area of narrow, about same width with ventral area; dorsal depression and ventral depression absent; crista superior not well-developed; dorsal margin lobed, with three lobes, the posterior lobe a short protraction; ventral rounded in outline, with a crenate margin; anterior and posterior surfaces irregular. Excrisura a nearly right angle gape; antirostrum less developed, with a flat or slightly convex margin; rostrum a large, pointed protraction extending well beyond the antirostrum. Pseudo-excrisura a deep concave; pseudo-rostrum a large triangular protraction. Sulcus groove very deep and wide, heteromorph; collum absent; a narrow and elongated ostium (anterior sulcus) connected to the very wide and oval cauda (posterior sulcus) directly. Colliculum heteromorphy, well-developed in cauda and less developed in ostium.

Coloration. Uniformly reddish black when fresh and dark black when preserved. Gular region and outer margin of gill chamber pale with pigmented ridges; lateral-line scales grayish.

Etymology. Named after Dr. John E. McCosker, senior scientist of the California Academy of Sciences, in recognition of his interest in and contribution to our knowledge of flashlight fishes.

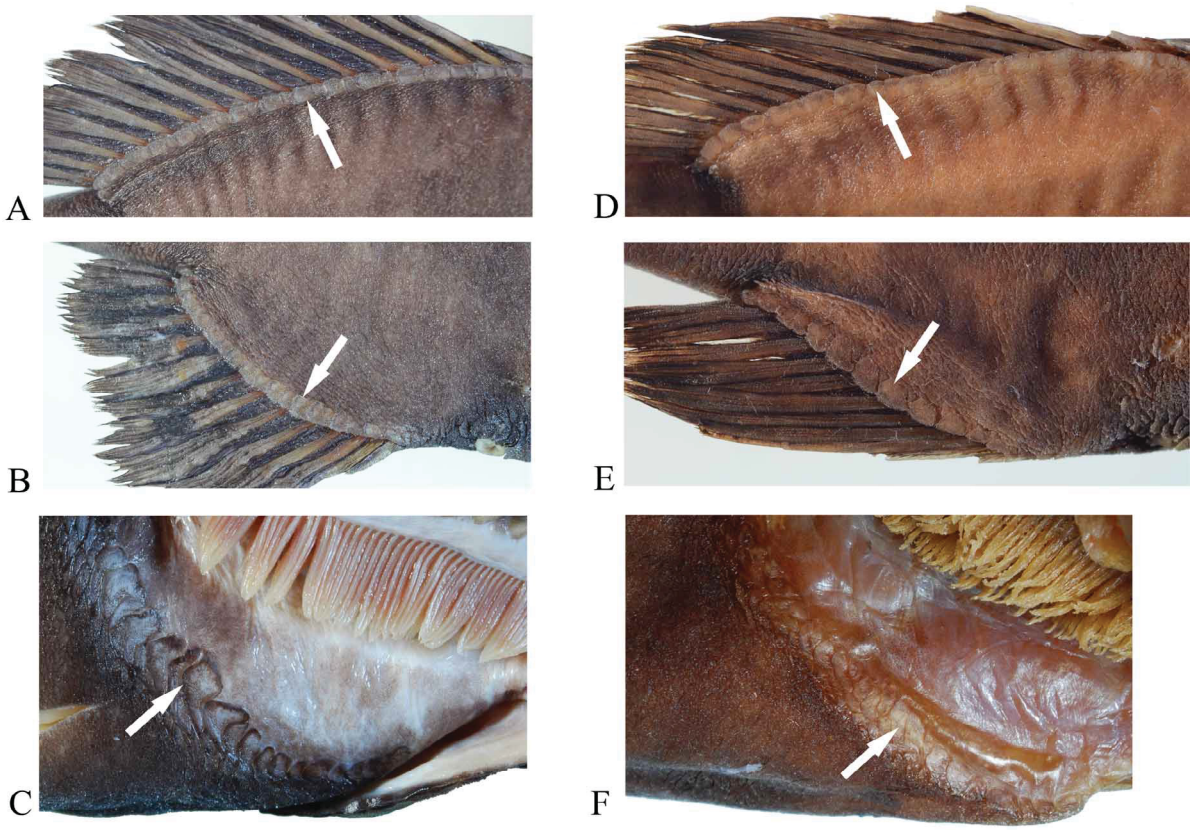

FIGURE 6. A–C. *Protoblepharon mccoskeri*, preserved holotype. D–F. *P. rosenblatti*, preserved holotype. A, D. Lateral view of right dorsal-fin base showing enlarged scales. B, E. Lateral view of right anal-fin base showing similar scales. C, F. Lower part of right gill chamber showing enlarged smooth plate-like scales along outer margin. Arrows indicate enlarged scales. Not to scale. Anterior to right.

Comments on *P. rosenblatti* Baldwin, Johnson and Paxton

Based on re-examination of the holotype (AMS I. 24275-001, 220 mm SL), here we describe several characters not mentioned in the original description of *P. rosenblatti*. Palatine teeth forming a rod-shaped patch with irregular margin lacking the hook its anterior end that forms a J-shaped patch in *P. mccoskeri*. Two to three rows of irregularly shaped plate-like cycloid scales along outer margin of gill chamber (Fig, 6F) vs. one row of relatively large similar scales in *P. mccoskeri* (Fig. 6C). Ninety-seven (52 on right + 45 at left) enlarged scales along dorsal-fin base and 22 (11 at each side) along anal-fin base. A third row of flat, tooth-plate type gill rakers between the other two rows on each lower limb of second and third arches. The original description reported the number of abdominal scutes as nine, whereas we count 13 (with the 7th not clearly defined).

Fourteen abdominal and 16 caudal vertebrae, including second ural centrum. Dorsal fin supported by 21 anteroposteriorly exapnded pterygiophores (seven spinous, 14 soft ray); one supraneural anterior to the first and second neural spines. Supraneural and pterygiophore insertion formula 0/0/1+1/1/1/1/1/1/0/1/1/1/1/1/2/3/3. Anal fin supported by 12 anteroposteriorly expanded pterygiophores, first three inserting anterior to haemal spine of first caudal (15th) vertebra.

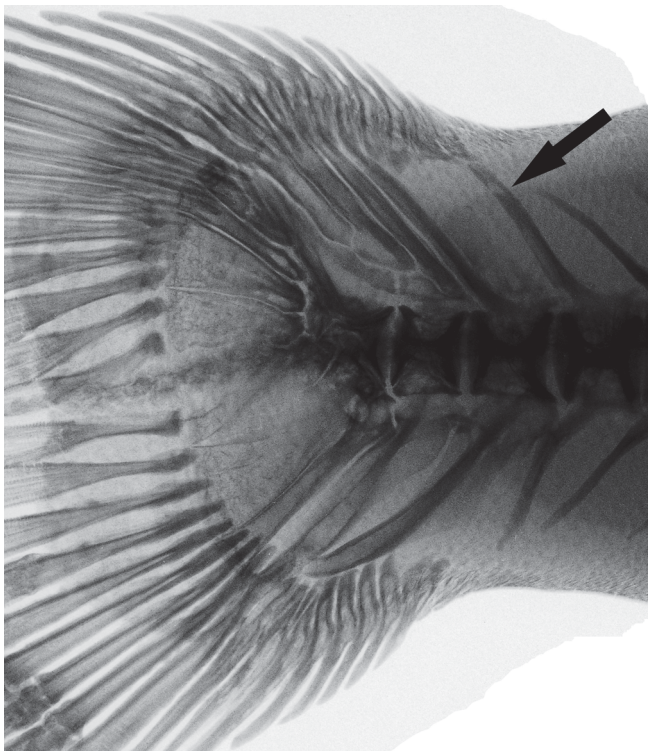

FIGURE 7. *Protoblepharon mccoskeri*, preserved holotype. Radiograph of caudal skeleton. Arrow indicates 4th preural neural spine.

FIGURE 8. Sagittal otoliths of *Protoblepharon mccoskeri*, from the holotype. Upper, distal surface of right otolith. Lower, proximal surface of left otolith.

Comparative material

Holotype of *P. rosenblatti*: AMS I.24275-001, 220 mm SL (209 mm SL in original description), northwest of Matavera, Rarotonga, Cook Islands, 21°12'S, 159°45'W, depth 274 meters.

Acknowledgements

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